

On the Ophiuridæ of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson, F.R.S., Superintendent of the Museum. By Prof. P. MARTIN DUNCAN, M.B. Lond., F.R.S., F.L.S.

[Read 3rd June, 1886.]

(PLATES VIII., IX., & XI. figs. 28-40.)

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I. *Introduction.*

THE species of Ophiuridæ which form the subject of this communication were handed over to me by Dr. Anderson for description and classification.

The little fauna is rich in individuals, and some are of considerable dimensions. There are thirteen species, besides some young forms of the genus *Ophioglypha*, in the collection, and four of them have been recorded from other localities. The latter are, with one exception, well-known species; they are *Ophiolepis cincta*, Müll. & Trosch., *Ophiocoma scolopendrina*, Lmk. sp., *Ophiocnemis marmorata*, Lmk. sp., and *Ophiothrix Martensi*, Lyman. These forms are characteristic of the Indian Ocean and the western Pacific Islands. The first extends to the Philippines, the second ranges from the Cape of Good Hope to the Philippines and Fijis, the third has been found in Ceylon and in the Great Ocean, and the fourth is from the Philippines. None of the Korean species are present; and one *Ophiothrix* is closely allied to a species from the Nicobars.

All the species are shallow-water dwellers; and some of the individuals appear to have suffered from a deficiency of carbonate of lime in their food.

There are some remarkable forms amongst the collection, and especially the new species of *Ophiolepis* and the new genus *Ophiocampsis*, represented by one species, which is allied to *Ophiopsammium* and *Ophiothrix*. The species of *Ophiothrix* gave much trouble in their classification; and the structures of *Ophiothrix variabilis* have been of necessity carefully studied. Their description forms the subject of a special communication, which follows this.

II. *List of the Species described or noticed in this
Communication.*

Order OPHIURIDA, <i>J. Müller.</i>	Family OPHIUCOMIDÆ, <i>Ljn.</i>
Family OPHIOLEPIDÆ, <i>Ljn.</i>	Ophiocoma scolopendrina, <i>Lmk.</i> , sp.
Ophiolepis cineta, <i>Müll. & Trosch.</i>	Family OPHIOTHRICIDÆ, <i>Ljn.</i>
— nodosa, sp. nov.	Ophiothrix Andersoni, sp. nov.
Ophioglypha, <i>Lyman</i> , numerous young forms.	— merguensis, sp. nov.
Family AMPHIURIDÆ, <i>Ljn.</i>	— Martensi, <i>Lym.</i>
Ophiophragmus affinis, sp. nov.	— variegatus, sp. nov.
— difficilis, sp. nov.	— variabilis, sp. nov., and four varieties.
Ophiocnida sexradia, sp. nov.	Ophiocampsis pellicula, gen. et sp. nov.
	Ophiocnemis marmorata, <i>Lmk.</i> , sp.

III. *Description of the Species.*

Genus OPHIOLEPIS, *Müll. & Trosch.*

OPHIOLEPIS CINCTA, *Müll. & Trosch.*

Locality. King Island.

OPHIOLEPIS NODOSA, sp. nov. (Plate VIII. figs. 1-3.)

Disk large, much notched over the arms, covered with very small wide-apart radial shields and a thick skin ornamented with large knobs placed symmetrically and surrounded by small irregular scales. Large projecting knobs in the interbrachial spaces. Below, the scaling is both large and small, and the smaller plates surround the larger; large scaling at the margin.

Mouth-papillæ numerous, and with accessory papillæ. A supplementary plate orally to the mouth-shield. Arms short and broad; upper arm-plate nodular; small accessory plates on either side of upper and lower arm-plates; four to six very small spines along the arm. Two tentacle-scales.

Description of the Specimen.—Disk nearly as wide as the length of an arm, tumid above and at the margin between the arms, notched over them. Nodules five in centre, two in each interradial space, and five largest between the central group and the radial shields. Radial shields very small, naked, almond-shaped, widely separated by two nodules and intermediate scaling. Scales between the nodules varying in shape and size, never regular or in single series. At the margin, between the arms, the nodules are very large and five in number, and separated by a narrow scaling. Immediately below these are five

large and symmetrical plates; the rest of the plates diminish in size from the margin to the mouth-shields; and there is a row of irregularly-shaped scales between them.

Two generative slits, and the scale apparently divided into three parts.

Mouth-shields small, ovoid, narrowest externally, and with a small accessory piece between the mouth-shield and the junction of the side mouth-shields. Side mouth-shields each nearly as large as the mouth-shield, situated obliquely, and with the inner point of junction far internal to the accessory piece, triangular, and largest at the side, where they are in contact with the first lower arm-plate, the first side arm-plate, and the mouth-shield. Jaw-plate angles broad and long. Mouth-papillæ mostly projecting downwards, irregular from the intercalation of accessory papillæ; there are 13 in one angle, and 11 and 12 in the rest. There may or may not be a papilla below the teeth, which are stout and blunt, except the lowest, which is pointed. A long papilla, which is in contact with the side mouth-shield and also with the first arm-plate, is large and triangular, and might be called a tentacle-scale. The accessory pieces are small and resemble mouth-papillæ.

First lower arm-plate small, triangular, pointed within. The next is very large and is broader than any other, broader than long, straight where in contact with the first plate, slightly convex externally, and with a re-entering curve on either side of the straight part; incurved for the tentacle at the part of the side nearest the first plate, and more slantingly incurved further out for the side arm-plate. Beyond the disk the plates are as long as broad, slightly convex without and concave within, with re-entering curves on either side and a straight border for the side arm-plate. Far out they are separated by the side plates, and are triangular, the angle being towards the disk.

Upper arm-plates small, short, and moderately broad, not extending across the arm, the usual space at the side being occupied by a triangular accessory plate which reaches the side arm-plate; the surface of the upper plate is a nodular broad ridge with a blunt point at the median line. Side arm-plates large, tumid, but close to the arm, gradually having the accessory piece between them, and crossing the upper surface of the arm close to the tip. There are two close, flap-like tentacle-scales, and from four to six, usually four, very small spines placed close to the

arm. The tentacular openings are bounded, without, by a small, short, and increasingly broad accessory plate.

Arms short, with a leathery skin at the disk-notches, capable of much horizontal motion, and broad and flat below, low at the sides, and more or less angular above from the presence of the nodular upper arm-plates.

Colour in alcohol orange, with a little purple splashed on the radial shields, nearly white below.

A remarkable cribriform structure exists in many parts; for instance, on the bases of the boss-like nodules of the disk, on the sides of the radial shields, on the flanks of the nodules between the shields, on the sides of the large bosses at the margin, on the upper flap of the side arm-plates, and on the upper arm-plate except the boss.

The jaw-frames are slightly cribriform, and so are the side arm-plates, as seen from below, and here and there a few pores occur on the lower arm-plates. The cribriform character is produced by a close, shallow, circular perforation, or rather penetration, of the calcareous structures.

Diameter of disk 18 millim. Length of arm 17·5 millim., breadth of arm outside the disk 3 millim.

Locality. Elphinstone Island.

Genus OPHIOGLYPHA, *Lyman*.

Numerous young forms of indeterminable species.

Locality. Elphinstone Island.

Genus OPHIOPHRAGMUS, *Lyman*.

The next two forms to be considered have given some trouble in regard to their classificatory position; for whilst having the general aspect and some of the characters of the genus *Amphiura*, there are some of the internal, as well as external, structures present of the genus *Ophiophragmus*, Lym. Some of the internal structures are, however, Amphiuuran, and are not seen in the type of *Ophiophragmus* figured by Lyman, 'Challenger' Report, Ophiuroidea, pl. xl. fig. 4.

1. The junction of the mouth-frames, superiorly and at the median line adorally to the first arm-bone, is stout and projecting. The upper brachial rims of the contiguous halves, to use Lyman's words, "form an elevated crescent embracing the outer end of the mouth-slit"; moreover, the interbrachial rims are in

the form of well-developed crests; they are rather close, and the intervening muscle is well developed. These are *Ophiophragman* characters. But the width of the mouth-frames is greater, and the height of the interbrachial rims is less than in *O. Wurde-manni*, Lym. Probably the very narrow mouth-shield determines the narrowness of the space between the interbrachial rims of the mouth-frames, as seen from above.

2. The first three arm-bones within the disk, as seen from above, after the removal of the roof of the disk, resemble those of *Ophiophragmus*; but those further out resemble those of *Amphiura*.

3. There is a peristomial plate, and the character is not *Ophiophragman*, but it resembles that of *Hemipholis*.

4. The genital plate is long and slender, and simply knob-headed, and the generative scale is long and slender and longer than the plate. They resemble the corresponding structures in *Amphiura* more than those of *Ophiophragmus*.

5. The radial shields are unusually broad for an *Amphiuran*, yet not more so than in some recognized species.

6. The ridge of scales at the margin of the disk, although slight, is *Ophiophragman*; but it cannot be of any physiological importance.

Probably the species should be classified with the genus *Ophiophragmus*, although the *Amphiuran* alliance is evident.

OPHIOPHRAGMUS AFFINIS, sp. nov. (Plate VIII. figs. 4-6.)

The disk is circular in outline, except where slightly indented over the arms, and it is rather tumid. The scaling is small above, but distinct, and is largest centrally and in the interradial spaces. Primary plates not very conspicuous. On the underside of the disk the scaling is smaller and overlapping. A ridge of minute scales at the interbrachial margins projecting. Radial shields twice as long as broad, pip-shaped, close and joined except near their inner ends, where a single scale intervenes: a projection on the outer angle. Mouth-shields small, spear-headed, blunt, angular orally, and with a stalk-like process aborally, covered with a thin skin. Side mouth-shields small, covered.

Jaws broad; four mouth-papillæ on each side—the outer on the side mouth-shield, the two following more or less united, and the innermost below the teeth, but sloping somewhat besides projecting inwards.

Arms long, 5.5 times the diameter of the disk in length, slender,

filiform at the end, flat below, and convex above. Lower arm-plates very broad, broader than long, twice as broad as long for some distance beyond the disk, nearly quadrangular near the disk, and with a point at the median line adorally, incurved aborally lower down, with an inward curve at the sides for the tentacular opening. A low, broad elevation runs along the median line of each lower arm-plate.

Upper arm-plates large, much broader than long near the disk, slightly convex adorally from side to side; the aboral edge is the widest, and the adoral is boldly curved adorally. Further out the plates are elliptical and broader than long, but near the tip the length increases over the breadth. The side arm-plates are small flaps close to the arm, which soon encroach slightly between the upper and lower plates, and the separation of the upper arm-plates by them soon becomes considerable.

Three short, cylindrical, pointed spines stick out widely from the arm and from each other, the middle one the longest and thickest.

Two tentacle-scales over the large tentacular openings, broad and pointed—one is on the side arm-plate, and the other on the lower arm-plate. They reach far out in the arm, and the scale attached to the lower arm-plate becomes longer. Diameter of disk 4.5 millim. Length of arm 26 millim. Colour white and flesh-tinted.

Localities. Elphinstone Island and King Island.

One of the commonest species of the Ophiurida in the Archipelago is a small, slender, long-armed form, which is usually found without a top to the disk, and, moreover, the middle of the upper arm-plates is wanting for some little distance beyond the disk. The genital plates and scales, the interbrachial parts, and the whole of the top of the disk are then absent. In two instances the disk has been preserved, and it is possible therefore to describe the species fully and to classify it.

OPHIOPHRAGMUS DIFFICILIS, sp. nov. (Plate VIII. figs. 7-9.)

The disk is small, flat, strongly pentangular, with a well-defined re-entering curve at the margin between the radial shields.

Diameter 5 millim. Length of arm 70 millim. Disk covered with a minute overlapping scaling except on the radial shields. A large scaling at the margin. Radial shields long and narrow, but forming much of the disk, and close except midway; the ends

project over the arm and are close; the outer sides overlapped by scaling. Genital plate slender and long, rod-like, articulated with the radial shield, and having a slight expansion at its inner part over the arm; it arches into the longer and equally slender genital scale. The aboral ends of the united genital plate and scale overhang the arm and nearly touch their neighbours at the median line.

Generative openings large. Interbrachial spaces below with a plain skin, the only scaling being on the side of the genital slit and on a line with the oral end of the generative scale, and it consists of a close row.

Mouth-shields longer than broad, broadly rounded without and narrower and more angular within. Side mouth-shields large, broad at the side of the arm, and long from side to side in front of the mouth-shield, only separated by the very small first arm-plate.

Jaw-angles broad and short, with four mouth-papillæ on either side, of which one is stout and immediately below the true teeth, the next is small, and the following pair are frequently united. These eight papillæ, which are very constant, project downward.

The arms are long, filiform, and slender, but they do not diminish much in breadth; they are rarely otherwise than straight, and usually three are in one direction, and all look like stiff wires rather than threads. Lower arm-plates: the first is very small, incurved orally, and convex at the edge without, touched on either side by a side mouth-shield; the second is much larger, is quadrangular, but longer than broad, broadest orally, and convex at the edge without. Beyond the disk the plates are much longer than broad, slightly broadest at the inner edge, which is convex, and with sides straight and slanting to the narrower outer edge, which is incurved. In mid arm the length preponderates over the breadth, and the breadth is greatest at the edge within, and this is convex, while the edge without has a decided incurve. At some distance from the disk the plates are not close, on account of the side arm-plates coming in.

Upper arm-plates broadly triangular, point without, angles at the sides and without rounded off; oral edge broad and slightly curved within. Usually with a small median ridge. The median part of the first six or eight upper arm-plates deficient.

Side arm-plates large, projecting obliquely, meeting, not far from the disk, on the underside of the arm broadly, and thus

separating the lower arm-plates there; meeting on the upper surface of the arm close to the disk by a narrow surface. The spines are on the exposed narrow edge of the plate, and are three in number except close to the disk, where there is a fourth. They are subequal, short, stout, cylindro-conical, striated, sharp, and glassy; their length is not equal to that of the width of the upper arm-plate. The tentacle-scale is small and spinulose. Tentacles long and stout. The colour of the animal is either light, brown or white.

With regard to the internal construction of the skeleton, it appears that the form of the upper part of the arm-bones resembles that seen in *Amphiura*, but there is an approach to the peculiar structure of the genus *Ophiophragmus* in the crescentic junction of the mouth-frames at the mouth-slits; moreover, the interbrachial rims of the frames project and are not widely separated. There is no peristomial plate. The position assumed in the specimens by the genital plates and scales is very remarkable, but it may be due to post-mortem causes. The oral ends of the plates and scales, instead of being parallel with the side of the arm in continuation with the general direction of the rest of the structure, are in contact with the side arm-plates immediately below the position of the aboral ends of the radial shields. The plates and scales are thus nearly vertical and the end of a radial shield is forced up to a much higher level than the top of the arm, and of course there is a considerable space between the upper surface of the arms and the underpart of the disk.

Locality. King Island.

Genus OPHIOCNIDA, *Lyman*.

OPHIOCNIDA SEXRADIA, sp. nov. (Plate VIII, figs. 10, 11.)

Disk small, tumid above and at the margin, irregularly hexagonal, covered with a thick skin with numerous close, short, thorned stumps.

No scales or radial shields are visible. A skin with a very delicate, small, overlapping scaling is in the interbrachial spaces below, and there are some stumps on it near the margin. Two large generative slits, which come as far inwards as the aboral process (genital scales) of the mouth-shield. Mouth-shields small, about as long as broad, lozenge-shaped with the angles rounded. Side mouth-shields small, short orally, and largest near the arms, usually not meeting orally, and touching the first and second

arm-plates. Jaw-angles triangular, broad and short, with a median perforation. Mouth-papillæ numerous, eight to an angle, not counting the tentacle-scale on either side. There is one also beneath the teeth, so that there may be from 9 to 11. Tentacles large.

There are six long rather slender arms. First lower arm-plate small; second plate very much larger, longer than broad, broadest without, outer edge curved outwards, inner edge straight and slightly curved at the sides for the side mouth-shield. Beyond the disk the plates are longer and otherwise retain their outline, but the side arm-plate comes gradually under the arm and diminishes the width of the inner edge. Sides incurved. The large, long, flap-like, curved tentacle-scale abuts against the side of the lower arm-plate. The length of the plates increases over the breadth towards the tip of the arm, and they are separated by the side arm-plates. The tentacle-scale becomes more pointed towards the end of the arm. Upper arm-plates large, heart-shaped, broadest aborally and curved there, narrower orally and roundedly angular there; sides convex. The side arm-plates come in at the half-arm. Side arm-plates large, flap-like, projecting somewhat near the disk and more flattened to the arm further out, so that the direction of the spines differs; meeting above and below the arm slightly beyond its outer half. Four close, cylindrical, conical, short, stout spines; their length is less than that of an upper arm-plate and they are longest in mid arm. The upper spine is either the longest or it may be short, the next is the stoutest as a rule, and the others are shorter and more slender. Their surface is plain or minutely jagged. Arms six, high, flat above and below, and nodulated towards the tip. Diameter of disk 4 millim.; length of arm 18 millim. Colour light brown, without any spots.

Locality. Owen Island.

Genus OPHIOCOMA, *Agass.*

OPHIOCOMA SCOLOPENDRINA, *Lmk.*, sp.; *Müll. & Trosch., Syst. Aster.* p. 101 (1842).

Several specimens of this species are in the collection from Mergui; and as there are some interesting points about their variations from the type and from one another, notice is taken of them.

In the largest specimen, which has a disk 25 millim. across and

arms 130 millim. in length, the upper, swollen, large, flat arm-spine is on every other side arm-plate, and near the end of the arm the upper spine is the longest and largest, but it is neither flat nor swollen. In one of the arms the normal repetition of a large flat spine occurs on every side arm-plate. The granulation of the disk is hemispherical, small, and not crowded; the largest nodules are on the ends of the radial shields. The granulation is smaller below. The wide generative slits come inwards so as to be bounded orally by the side mouth-shields, and these do not always meet orally. Two or three mouth-papillæ merge into a ridge, and the inner mouth-papillæ are not readily distinguished from the lower tooth-papillæ. The mouth-shields project considerably along the median line into the jaw-angles. The first three lower arm-plates form a groove. The double tentacle-scale is seen near the disk, but not very far out in the arm; there it is single, large, and flap-like. At the tip of the arm the lower arm-plates are very long.

In a smaller specimen (diameter of disk 22 millim., length of arm 120 millim.) the spines are shorter than in the form just noticed, the lower arm-plates are broadly elliptical in mid-arm, the skin coming well between them. There is no coalescence of the mouth-papillæ, and there are three on either side and one below the tooth-papillæ.

The large tentacle-scale in contact with the side mouth-shield and first arm-plate may be counted besides as a mouth-papilla.

In a small specimen (disk 9 millim. and arm 65 millim.) the granulation of the disk is crowded above and large at the margin. Underneath, the minute scaling, which is obscured by pigment in the large forms, is visible and the granulation does not extend *en masse* to the mouth-shields and only a few stray nodules occur thus far inwards.

The mouth-papillæ are either confused with the lower tooth-papillæ or are not, or one may be on the jaw-angle external to the tooth-papillæ clump. Including the large tentacle-scale, there are four mouth-papillæ on either side. The side arm-plates come under the arm and are in contact near the disk, but not further out. The lower arm-plates are rather hatchet-shaped beyond the disk, but they become very long towards the tip. The upper arm-plates are widest without and convex there. The spines are miniatures of those of the large forms. Two tentacle-scales near the disk and one further out.

The variability is remarked by Mr. Lyman in his Report on the 'Challenger' Ophiuroidea, p. 170.

Locality. Owen Island.

Genus OPHIOTHRIX, *Müll. & Trosch.*

OPHIOTHRIX ANDERSONI, sp. nov. (Plate IX. figs. 12, 13 ; Plate XI. figs. 28-30.)

The disk is circular in outline, large and tumid. The radial shields are large and naked. Minute scales with slender 2- to 4-thorned stumps in the centre of the disk, between the radial shields and the pairs of shields. A single series between the radial shields of a pair and four close rows in the interradi al spaces. Scales overlap the radial shields somewhat. Similar small scales and stumps at the margin of the disk. Below, the disk is covered with minute scales bearing stouter stumps than those above and with five to eight long thorns to a stump.

Mouth-shields small, much broader than long, more or less elliptical, but angular within and rounded without. Side mouth-shields small, largest at their sides, and meeting in front of the mouth-shields by a narrow edge. Jaw-angles short, very broad close to the side mouth-shields, with a small opening at the median line and large tentacular orifices. Tooth-papillæ and teeth, the former in an ovoid space, small and crowded inferiorly ; lower ends of the ovoids very wide apart from those opposite, so as to produce a funnel-shaped mouth.

Arms broad, arched, high and long, ten times the diameter of the disk in length. Lower arm-plates broad and flat ; some, within the disk, are longer than broad, but the breadth gradually increases over the length ; they are broadest aborally. The plates near the disk have the outer edge much curved, convexity towards the tip of the arm, and the edge within is slightly incurved. Further out in the arm the plates become longer than broad, and are slightly convex at both of the edges as well as curved out at the sides. A broad purple band passes down the under arm, which has a white colour.

The upper arm-plates are convex from side to side, much broader than long, short, broadest and curved at the aboral edge and narrower and incurved adorally ; sometimes the aboral edge has a slight incurve at the median line. The breadth diminishes in relation to the length towards the tip of the arm. The colour of the plates is a smalt-purple, and a narrow white band crosses each plate. The first plate has a few thorned stumps on it.

The side arm-plates are small and flap-like, especially on the lower surface of the arm. They contribute to the breadth of the arm, and do not meet until near to the tip of the arm. There is a small scale as a tentacle-spine. The number of spines varies in different parts of the arm; there are nine close to the disk and then seven, six, and five, which is the usual number over the greater part of the arm. A small glassy spine with side spinules is seen on a few plates near the disk, and it becomes a true hook with four fangs at the seventh arm-joint, and the points of the hooks, which are close to the tentacle-scale, look towards the disk. The other spines are glassy and usually compressed, so that their large lateral spinules are directed parallel with the arm. The upper spine, which is the longest and slenderest, is needle-shaped, sharp, and the spinulation is near the top and slight on the stem. The next spines diminish in length, are long, compressed, very spinulose near the top and less so on the stem. The spine next to the hook is very compressed, and has long and sharp spinules. Longest spine 3·5 millim. Breadth of disk 14 millim.; length of arm 140 millim.; breadth of lower arm-plates near the disk 1 millim. Colour of disk above dark purple, darkest centrally and along the interradia and spaces between the radial shields of a pair, relieved with smalt and white in splashes and lines near the edges of the radial shields.

Localities. King Island Bay, Elphinstone Island.

OPHIOTHRIX MERGUIENSIS, sp. nov. (Plate IX. figs. 14, 15; Plate XI. fig. 31.)

Disk nearly circular in marginal outline, covered with skin in which there are minute scales, each bearing a short three-thorned stump. Radial shields covered with a coarsely granular skin, also with a few trifold stumps; shields broadest at the margin and projecting over the arm, separated from the neighbouring pairs by a wide area covered with minute scales and bearing thorny stumps; a narrow line of the same structures between the shields of a pair.

Disk tumid beneath and covered in the interbrachial spaces with crowded trifold stumps. Mouth-shields as broad as long, broadly curved without and angular within. Side mouth-shields small, triangular, meeting at a narrow point orally to the mouth-shields, and not reaching aborally beyond the line of the mouth-shields. Jaw-angles wide and short, perforated along the median

line with immense tentacular openings; tooth-papillæ numerous and in a broad ellipse. Lower arm-plates beyond the disk flat and wide, nearly square or very slightly longer than broad, a re-entering curve at the outer edge, and a slight slanting at the sides for the side arm-plates. Further out in the arm the plates are longer than broad and widest without. Upper arm-plates broader than long, curved within and without, the convexity directed aborally, sides slanting for the side arm-plates; these are large, broad below, and flap-like at the sides, and they add to the height of the arm, which is flat below and arched above. Tentacle-opening large, and the scale is very small; tentacles large, long, and very papillose. Six spines, the lowest being a hook, small and 3-pronged; it is not found upon the first four or five joints. The next spine is small, compressed and serrate; the third spine is longer and also compressed, but is longer and blunt at the top, but it is serrate. The fourth spine is very long, but oar-shaped near its blunt broad top, it is very serrate, and is four times the length of a lower arm-plate (fig. 31). The fifth, or uppermost, spine is usually shorter than the last mentioned and its shape varies, it being often needle-ended. The spines in alcohol are dark coloured and opaque, and in balsam they are glassy with pigment-spots here and there. General colour of the disk and arms very dark red-brown. Diameter of disk 6 millim.; length of the arm 55 millim. or 1 to 9.

Locality. Owen Island.

OPHIOTHRIX MARTENSI, *Lyman, Bull. Mus. Comp. Zool.* vol. iii. pt. 10, p. 234, pl. iv. figs. 9 & 10 (1874); and 'Challenger' *Ophiuroidea*, p. 221.

This belongs to the group of Ophiotrices with arm-spines clubbed at the end and well-marked radial shields.

Locality. Owen Island.

OPHIOTHRIX VARIEGATUS, sp. nov. (Plate IX. figs. 16, 17; Plate XI. figs. 37-39.)

Disk tumid, projecting in the interradial parts of the margin, covered with a growth of small, slender, long-thorned stumps; thorns one to four in number. Stumps smallest and shortest at the centre of the disk, and slightly larger and longer towards the margins. No scales visible except the very small granulated thorny radial shields. Radial shields with a V-shaped space between and this has thorny stumps, and there is a broader stumped area between the pairs.

Beneath, no large scaling occurs, and the interbrachial spaces are covered with slender, long-thorned stumps which diminish in numbers towards the mouth-shields.

Mouth-shields small, one third broader than long, either lozenge-shaped or more or less rounded aborally and angular orally, projecting on either side; with a large adoral genital scale attached on either side to the median line aborally.

Side mouth-shields small, triangular, and not meeting adorally to the mouth-shields. Jaw-angles short, broad, with a wide median opening; tentacular opening considerable, and the tentacle long and papillose. Tooth-papillæ small, crowded, especially inferiorly, in a narrow blunt ovoid space. Teeth. Genital slits large and reaching mouth-shields; genital scale in contact with slender genital plate, broad, pointed orally and arched, shorter than the plate. First lower arm-plate small, second as long as broad, flat, re-enteringly curved adorally, with an aboral convexity. Sides slightly incurved. The sixth plate is broader than long, flat, almost rectangular, with a slight outward curve at the sides; further out, the plates have the aboral margin incurved, and towards the tip of the arm the shape is preserved, but there is a projection from the adoral edge towards the next or adoral plate. Upper arm-plates broader than long, convex at the outer margin, and concave and overlapped adorally, broadest at the outer margin. Arms high in section and arched. Side arm-plates large and flap-like, adding much to the under arm. A tentacle-scale. Tentacles long, sharply papillose. Spines glassy, nine near the disk, then seven, and six, which is the usual number, not counting the hook which begins at the fifth joint. The three lowest spines next to the trifold hook are short and small, the next and the following are long, very broadly oar-shaped at the tip, serrate, and with a crowd of long terminal spinules, especially on one side (fig. 37); all are compressed. The uppermost spine is shorter than the next and is a needle. The longer spines are much longer than the breadth of an upper arm-plate. Diameter of disk 8 millim.; length of arm 50 millim., 1 to 6.25. Colour of disk above dark purple with light tints, the white stumps giving a frosted appearance. Upper arm-plates each banded with white along the aboral edge and with a longitudinal white stripe; ground-tint a smalt-purple, and lines of it interfere with the continuity of the white mark at the edge of the plates. Under surface of the disk white, with an occasional splash of purple in

the interbrachial areas and on the mouth-shields. Lower arm-plates white, with a small patch or line of purple on either side of the median line. Every four or five plates with more colour than the others, giving a banded appearance to the naked eye.

Locality. Elphinstone Island.

OPHIOTHRIX VARIABILIS, sp. nov. (Plate IX. figs. 18, 19; Plate XI. figs. 32-36.)

The disk is either circular or slightly pentagonal in outline, large, tumid above, covered with a skin (sometimes crumpling when dry) with very small scales, each bearing a short, stout, cylindrical, but slightly tapering stump having a crown of very small thorns, three to six (usually four) in number. About six rows of these scales with stumps in the interrarial areas, and a crowd in the centre of the disk and at the margin in the interradia. Between the radial shields three rows of stumped scales. Radial shields large, longer than broad, projecting much over the arm, naked, granular, and with a few very low rounded knobs, especially towards the outer end.

Below, the disk has a skin in the interbrachial spaces extending to the adoral genital plates, which are attached to the mouth-shields aborally, covered with minute scales and rather crowded with slenderer stumps than above, and with one thorn only; they diminish in numbers towards the mouth-shield.

Genital plate in contact with the underpart of the radial shield aborally, and also articulating with a large, broad, wavy-edged genital scale. Mouth-shields small, broader than long, somewhat angular adorally or trilobed there. Side mouth-shields small, largest at the outer sides, narrow, and separated adorally to the mouth-shield, and not extending beyond the level of the long diameter of the mouth-shield aborally. Jaw-angles short, broad, separated by a considerable space, with a large tentacular area. Jaw-plate large, projecting slightly downwards, with 26 or more tooth-papillæ, the two highest being like a divided tooth, the rest large and long, except those placed near the lower margin of the plate, which is rather truncated. Teeth four.

Lower arm-plates narrow and grooved within the disk, square a little further out, then longer than broad, the length gradually increasing towards the tip of the arm. At a short distance from the disk they are slightly incurved at the aboral edge and curved, convexity adorally; the sides nearly straight or slightly incurved,

broadest near the adoral edge; either connected by skin or not, and then very closely placed.

Upper arm-plates arched from side to side slightly, broad, broader than long considerably, short, broadest without and curved at the aboral edge, near the disk, or slightly trilobed. Inner edge nearly straight or curved when the plates, as they often do, become elliptical; sometimes the sides are narrow and rounded off. Here and there a plate is split, but this condition may not occur in some arms. Side arm-plates flap-like, broad below, and not reaching over the upper arm until very far out. A small jagged tentacle-scale; tentacles large and long, crowded with whorls of papillæ. Spines, when the ectoderm is removed, glassy with large bases, hollow. At the emergence of the arms from the disk there are from seven to nine spines; further out there are six and usually five spines, the lowest being a double- or triple-fanged hook, with some minute spinules on the reverse side, which commences about the 12th joint or earlier, and then it assumes a more spiny form. The next spine is small, short, slightly compressed and very slightly spinulose; the next is longer and stouter, blunt at the top, compressed and oar-shaped at the end, where the spinules are small and crowded; serration but slight on the edges of the compressed spine, and foramina numerous. The second spine from above is the largest, longest and broadest at the end, minutely spinulose at the top, and slightly so for some distance down the shaft and then slightly serrate; perforations or foramina in several irregular rows. The blunt broad-tipped spines with their comparatively small spinules are distinctive. The first (upper) spine may be a small one and resemble the others, or it may be longer and a plain hollow needle.

Length of arms 12-14 times the diameter of the disk, which has a diameter of 13.5 millim. Colour of the disk dull purple, rather blue in tint, with a red tinge at the centre; radial shields lighter and with white background, splashed broadly with purple, low stumps and the others also whitish. Beneath, the disk is white with slight purple stains on the mouth-shields; interbrachial skin dark. Upper arm-plates purple or slate-colour, every fourth or fifth plate of a darker colour, and hence a banded appearance is given. Rarely a narrow stripe of the same colour, but of a darker tint. Lower arm-plates white within the disk, or with faint purple splashes, further out with a purple border more or less entire, with lines and dots of the same colour on a white ground. In-

tensity of colour varies in different individuals, and usually there is a banded appearance from the colour being lighter on consecutive plates. The spines are often slightly splashed with light purple.

Upper arm surface midway is 2 millim. across, and the length of the longest spine is a millimetre more.

Localities. Elphinstone Island, King Island, Owen Island.

Variety 1. Same dimensions as the type, hooks at the 10th joint. Upper arm-plates near the disk with the median aboral projection, sometimes a white line along part of the length in some plates.

Variety 2. General splitting of the upper arm-plates, near the disk, in some arms; upper arm-plates entire far out.

Variety 3. No splitting of the upper arm-plates, stumps extending in a close multitude below to the mouth-shield.

Variety 4. Stumps on the first upper arm-plate.

Genus OPHIOCAMPSIS, gen. nov.

Disk and large close radial shields covered with skin carrying a few thorned stumps. Ends of radial shields and the long knobs of the genital plates on the top of the arm; genital scale shorter, broad and large, with a curved border. Below, the disk has a plain skin carrying large, separate, irregular scales each with a thorny stump, crowded and large at the tumid interbrachial space and ceasing near the mouth-shield. Teeth, tooth-papillæ, no mouth-papillæ, and no tentacle-scales to the arms. Tentacles large, long, and papillose, coming out from the lower part of the arm. No upper arm-plates. A minutely squamous skin covers the broad, arched upper surface of the arm, and part of the sides of the arm and also the bases of the projecting flap-like side arm-plates. Spines long, slender, spinulose, glassy, seven to five in number, the lowest being a hook. Lower arm-plates narrow orally and aborally, widest in the midst, and with a projection at the sides. Arms about ten times the length of the diameter of the disk, rounded above and at the sides and rather flat below, can assume a vertical bending. Arm-bones with large umbo and without a median articulating peg.

OPHIOCAMPSIS PELLICULA, sp. nov. (Plate IX. figs. 20, 21; Plate XI. fig. 40.)

The disk is pentagonal, the scales at the margin are stout,

small, and white. The mouth-shields are broader than long, almost semicircular in their oral curve and more angular without. Side mouth-shields large at the side and narrow, and not always meeting orally. Jaw-angles short, much separated aborally, and having large tentacular openings and very large papillose tentacles. Teeth three in number. The tooth-papillæ are in a short oval, and the jaw-plate is very distinct. About ten to twelve rather large tooth-papillæ surround a line of from five to seven small papillæ, and the highest papillæ are like a true tooth split down the middle, and are therefore two in number. Strong second genital scales in contact with the aboral edge of the mouth-shields. Lower arm-plates feeble and thin, separated by some skin, longer than broad, narrow and slightly incurved orally and aborally, and broadest in their middle part near the disk; but further out the greatest breadth is near the aboral edge. A projection from each side, often bifurcate, causes the above-mentioned breadth and separates the consecutive tentacle-openings. Side arm-plates large, composing most of the arm, flap-like and very projecting; tentacle-openings close to the lower arm-plates, and opening below and not at the side of the arm. Seven glassy, slender, and hollow spines near the disk and far out, near the end five spines occur. The lowest spine, at a short distance from the disk, is a compressed, glassy, four- or five-pronged hook. The next three spines are on the under surface of the arm, and are longer than the hook, compressed and spinulose on both sides; the next spine is long, blunt, compressed, and has spinules near the top, some being hooked and a few on the shaft. Upper spine a needle either long or short, hollow. Longest spines longer than the breadth of the upper arm, this is 2 millim., and the spines may be 2.5 millim. The minutely squamous skin of the upper arm is coloured with wide bands of light and dark purple dots. Arm-bones formed to a certain extent after the type of *Ophiothrix*, but presenting a tall umbo and no median peg*. No upper arm-plates, and there is some nodulation far out in the arm at the joints. Colour of the disk brown, with a dot or two of purple at the ends of the radial shields and on the mouth-shields, lower scaling of disk opaque white. Diameter of disk 7 to 8 millim.; length of arm 60 to 80 millim.

Locality. King Island.

* See p. 117 in the next communication.

Genus OPHIOCNEMIS, Müll. & Trosch., *Syst. Aster.* 1842, p. 87;
Lyman, 'Challenger' Report, p. 228.

· OPHIOCNEMIS MARMORATA, Lmk., sp., Müll. & Trosch. *op. cit.*
p. 87.

The genus *Ophiocnemis* was insufficiently diagnosed by Müller and Troschel, and the amended definition of Lyman appears to be excellent with a doubtful exception. The lower part of the interbrachia is quite naked according to the first-mentioned authors, and scaled according to Lyman. In a specimen of *O. marmorata* from the Mergui Archipelago the skin is certainly naked and plain. The anatomy of the arms given by Lyman is as remarkable as correct, and the specimen I have examined has the peculiar characters given on Lyman's plate xlii. fig. 15.

There is no drawing of *Ophiocnemis marmorata*, Müll. and Trosch., and their definition is very short. I have therefore considered the diagnosis and allowed for the variation of such forms, and venture to suggest some few alterations.

The nodular stumps on the skin between the radial shields are not on visible scales, and they crowd the interbrachial margin, some being on the outer edge of the radial shields. They also crowd in the centre of the disk. Skin plain below. Generative scale large, broad, and arched below where free. A forked genital process on the aboral side of the mouth-shield. Side mouth-shields placed orally to the long diameter (from side to side) of the mouth-shields. First lower arm-plate very small. Beyond the disk the lower arm-plates are broader than long, incurved orally and aborally, longest at the sides, and slightly incurved there. They increase in length towards the tip. Upper arm-plates much broader than long, at least four times as broad as long, arched and semi-keeled near the end of the arm, edges within and without either slightly curved or straight. Tentacular opening well at the side of the arm in mid-arm; a very small tentacle-scale on the edge of the side arm-plate. Usually four spines, small, cylindro-conical, not sharp, striated, and not hollow, only less dense in the centre, banded with colour; dull white, opaque, and microscopically spinulose. The first becomes a glassy bifid hook at mid-arm; the fourth varies in size, and the third from the lower arm is the largest. Diameter of disk 13 millim.: length of arm 70 millim. Colour in alcohol generally brownish green with splashes of white, and dots, lines, and splashes of dark

green. Radial shields with white spots and lines. An indefinite ringing on the arms above.

Locality. Mergui. The species has been found at Ceylon, Zanzibar, and N. Australia (?).

A young form (diameter of disk 5 millim., arms 15 millim.) has the nodules on the skin of the disk well developed in the interradial areas, and there are stumps at the edge of the interbrachium where the skin below commences. There is some minute scaling at the centre of the disk, and the nodules are well seen. The upper arm-plate is arched from side to side, but the length is greater than the breadth. The hooks commence near the disk.

Localities. Elphinstone Island and Sullivan Island, 4 fathoms; King Island.

IV. *Remarks on the Species.*

The presence of *Ophiolepis cincta* was to be expected on account of the great range of the species, and the specimens show all the well-known characters of the beautiful form. The other species of *Ophiolepis*, *O. nodosa*, is new, and is a very remarkable and distinct form. Unfortunately only one specimen was found, but it was well preserved. Accessory scales and plates are in excess in this nodule-covered, bloated-looking species, for there is an unusual plate placed orally to the mouth-shields, and, besides extra mouth-papillæ, there is an accessory plate extending from the side arm-plates to the lower arm-plates transversely, and separating the consecutive tentacle-openings. This last character is seen in that extraordinary form *Astrophiuira permira*, Sladen, as well as in *Ophiolepis elegans*, Lyman. The great nodules on the upper arm-plates and the cribriform texture of many, but not all, of the plates are very remarkable.

Unfortunately the specimens of *Ophioglypha* are all too young for specific determination. The *Amphiura*-like forms, whose marginal rim of scales and internal construction have caused them to be relegated to the genus *Ophiophragmus*, Lym., are very interesting. Many of the specimens are found without their upper disks and genital scales and plates, so that the upper surface of the mouth-shields and interbrachial rims besides the upper part of the jaws and teeth are exposed. Even some of the specimens which have the disk preserved appear to have had some diminution in its size, for one or two of the upper arm-plates close to the edge of the disk as it now exists are wanting. They appear to be deficient in consequence of the disk once having been larger. The position of the genital plates and scales, which

has been noticed in describing the species, is most suggestive, and it is quite possible that the almost vertical direction, instead of the usual horizontal one, assumed by the plates and scales may have been necessary whilst the ovarian sac was filled with ova. Knowing how frequently Ophiurans die after parting with their ova, and how they sometimes suffer from defective amounts of carbonate of lime, I think that it will be worth while for the future to pay attention to the position of the genital plates and scales of Ophiurans which are living under unusual as well as under normal conditions. The anatomical details show that the characters of *Ophiophragmus* and *Amphiura* can be combined; and it is very probable that future research will place the genera closer together, or even decide that the first-named must become a subgenus of the latter. The importance of the differences of the internal construction of the mouth-frames mentioned and excellently illustrated by Lyman (*op. cit.*, 'Challenger' Report, pl. xl. fig. 4) may not be so great as is now considered, especially in view of the structure of the particular organs in *Ophiothrix variabilis*, nob., which will be considered in the next communication.

The new *Ophiocnida* with six arms, four arm-spines, and numerous mouth-papillæ is unfortunately founded upon a solitary specimen. Now that attention has been directed to this species, there is a possibility of larger specimens being obtained; it would be interesting to know whether the sixth limb is always retained.

The *Ophiothrices* are numerous in individuals, and there are some very interesting forms amongst them. Almost all have long arms, stumpy, thorned disks, and purple or sombre tints, and with some of the glassy spines on the arm broad at the top, oar-shaped, hollow, and compressed. In most of the species hooks are seen very near to the disk. In the majority the tentacles are large, long, and covered with whorls of papillæ. There is one species which has given much trouble in classification, for not only are there four fairly marked varieties, but the type has considerable external resemblances to *O. galatea*, Ltk., whilst the internal structures present shapes which remove the forms from the type chosen by Lyman in illustration of the anatomy of the mouth-frames and arms within the disk, namely *O. quinquemaculata*, Müll. & Trosch. ('Challenger' Report, pl. xlii. fig. 5).

The nature of these structural differences will be noticed in the following communication. The species *Ophiocampsis pellicula*, which can bend its arm in a vertical downward plane

and which has no upper arm-plates, being covered on the upper arm with a minutely squamous skin, has very interesting arm-bones; they will be considered and described in the succeeding pages. There is nothing to be added to the knowledge already published regarding the common *Ophiocoma scolopendrina*; but I have added some notes concerning *Ophiocnemis marmorata*.

DESCRIPTION OF THE PLATES.

PLATE VIII.

- Fig. 1. *Ophiolepis nodosa*, sp. nov. Upper surface, nat. size.
 2. Part of the under surface of disk and arm, magnified.
 3. Upper arm in part, magnified.
 4. *Ophiophragmus affinis*, sp. nov. Upper view, magnified.
 5. Part of disk below, magnified.
 6. Upper surface of arm and mouth-frame within disk, magnified.
 7. *Ophiophragmus difficilis*, sp. nov. Upper view, magnified.
 8. Arm and mouth-frames from above, magnified.
 9. Disk from below, magnified.
 10. *Ophiocnida sexradia*, sp. nov. From above.
 11. Part of under surface, magnified.

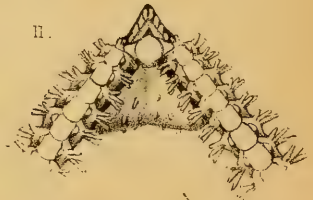
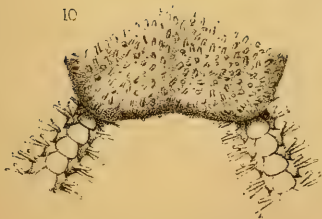
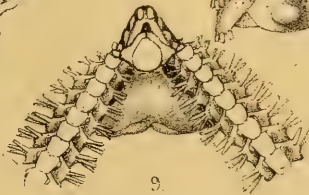
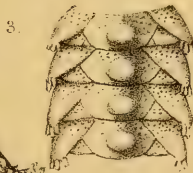
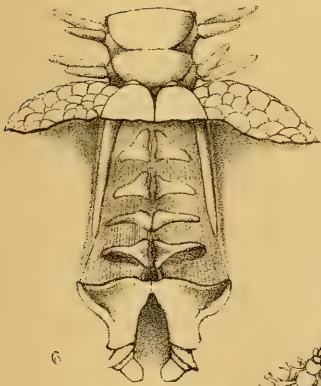
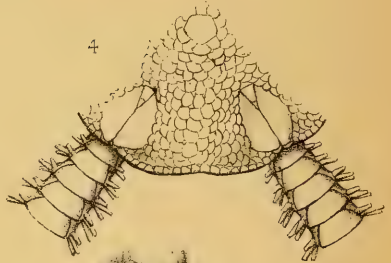
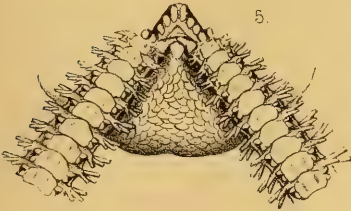
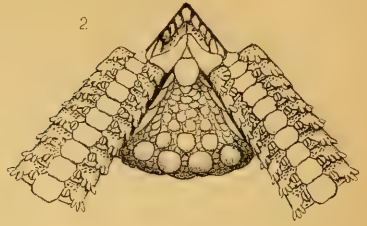
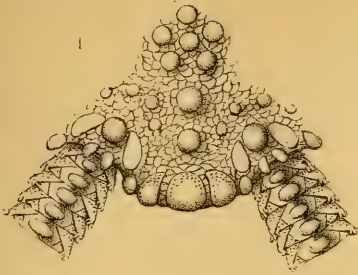
PLATE IX.

12. *Ophiothrix Andersoni*, sp. nov. Upper view.
 13. Part of under surface, magnified.
 14. *Ophiothrix merguiensis*, sp. nov. Upper surface.
 15. Part of the under surface, magnified.
 16. *Ophiothrix variegatus*, sp. nov. Upper surface.
 17. Part of the lower surface, magnified.
 18. *Ophiothrix variabilis*, sp. nov. Upper surface.
 19. Part of the lower surface, magnified.
 20. *Ophiocampsis pellicula*, sp. nov. Upper surface.
 21. Under surface, magnified.

PLATE XI.

(For description of the other figures (21-27) on this Plate, see p. 120.)

28. Spine of *Ophiothrix Andersoni*, magnified.
 29. Hook, magnified.
 30. Disk-stumps, magnified.
 31. Spine of *Ophiothrix merguiensis*, magnified.
 32. Spine of *Ophiothrix variabilis*, magnified.
 33. Section of spine, magnified.
 34. Small spine, magnified.
 35. Disk-stumps, magnified.
 36. Hook, magnified.
 37. Spines of *Ophiothrix Andersoni*, magnified.
 38. Hook, magnified.
 39. Disk-stump, magnified.
 40. Spine of *Ophiocampsis pellicula*, magnified.



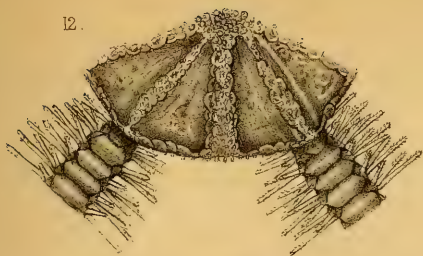
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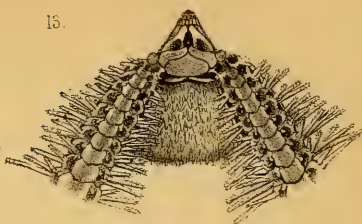
MERGUI OPHIURIDÆ

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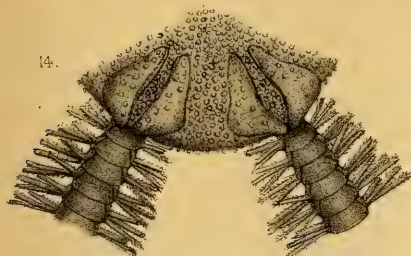
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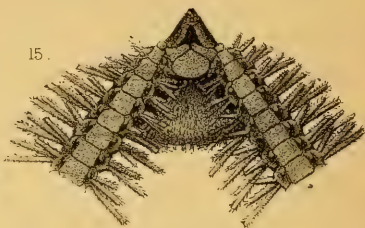
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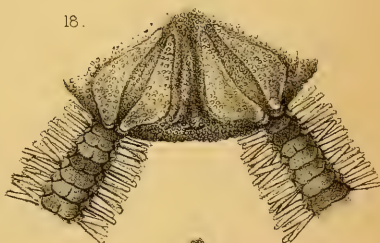
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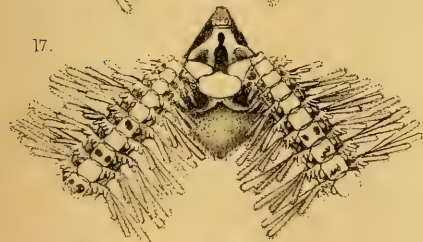
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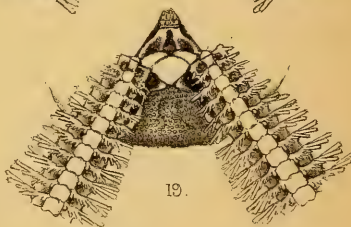
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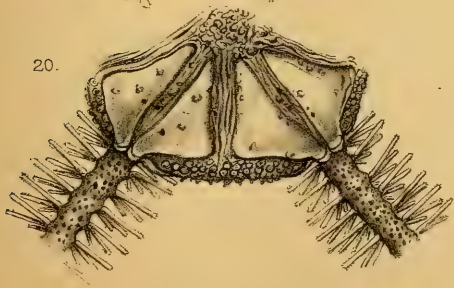
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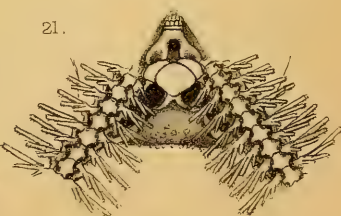
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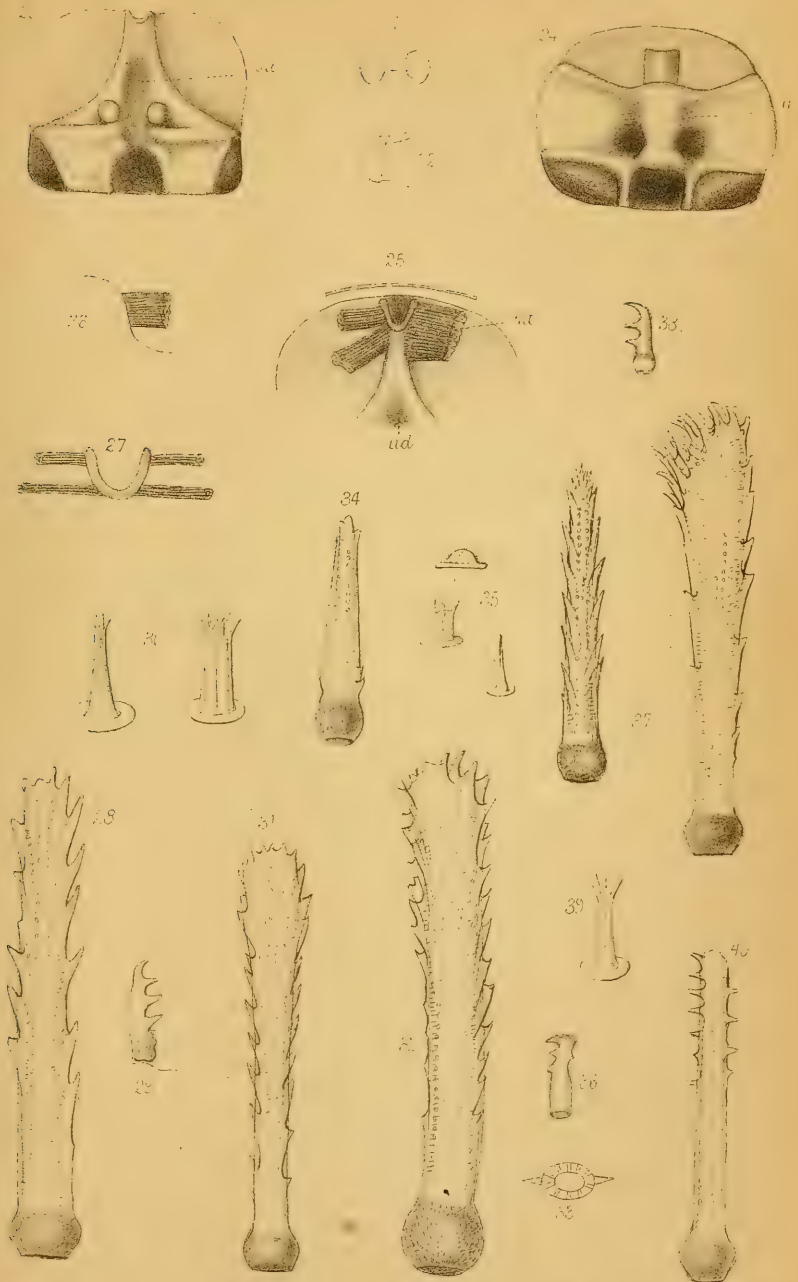
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P. M. Duncan del.



Benjean del et lith

P. M. Duncan del

Mintern imp

STRUCTURE OF OPHIURIDÆ.